Original Research

Proprioceptive Neuromuscular Facilitation versus Sensory Motor Training in Non-Specific Low Back Pain

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ABSTRACT

Background: *Non-specific low back pain is located in spine area and does not radiate to the legs. Non-specific low back pain can limit daily activities and cause inability to do work. The aim of this study is to compare the effectiveness of proprioceptive neuromuscular facilitation (PNF) versus sensory motor training (SMT) in the treatment of ultrasound therapy (UST) and kinesio tape (KT) insertion in non-specific low back pain.*

Methods: *This research is a randomized controlled trial (RCT) with pre-test and post-test control group design. The study participants were divided into two groups randomly. The control group (n = 10) is given UST+PNF+KT combination, while the treatment group (n = 10) is given UST+SMT+KT combination. Therapeutic evaluation measures include: pain scale with a numeric rating scale, range of motion with a goniometer, and low back disability with the Indonesian Version of Oswestry Disability Index. The intervention was given 3 times per week for 3 weeks. Data was analyzed using statistic software.*

Results: *The results showed improvement in pain, range of motion, and low back disability in each group (p<0.05). However, there were no significant differences when compared between groups. This could be because the therapy sessions were too short, the follow-up procedure was not carried out in the following week where the researchers did not know the effectiveness for long-term therapy, and the various methods of therapy application.*

Conclusion: *Based on these results, it can be concluded that the UST+PNF+KT combination has the same good results as the UST+SMT+KT combination in improving pain, range of motion, and low back disability in non-specific low back pain.*

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INTRODUCTION

Non-specific low back pain is defined as a type of low back pain that does not belong to a known specific pathology (fracture, ankylosing spondylitis, infection, osteoporosis, tumor, radicular syndrome, or cauda equine syndrome) and occurs in more than 94% of cases. Generally, pain is located in the spine or paraspinal area (or both) and does not radiate to the legs (Makeeva, 2016). Non-specific low back pain can limit daily activities and cause the inability to do work. The incidence of non-specific low back pain is higher in workers who perform severe physical activities such as lifting and carrying goods, work with repetitive movements, and static postures. The problems that arise from low back pain include: pain in the lower back area, limited joint motion, and decreased functional ability in carrying out daily activities.

The standard treatment that can be given to treat non-specific low back pain is ultrasound therapy (UST) modalities. The administration of 1 MHz continuous UST with an intensity of 1.5 W / cm^2 or 2.0W / cm^2 has the ability to heat the periarticular lumbar tissue to a sufficient degree to produce a therapeutic effect with increased temperature including pain reduction, reduction in joint stiffness, tissue healing, and changes collagen extensibility (Ebadi, et al., 2013).

In addition, the insertion of kinesio tape can also be used as a standard in overcoming non-specific low back pain. Kinesio taping (KT) is an elastic band designed to support muscles, tendons and ligaments and reduce pain. KT helps improve circulating blood flow and as a result, increases the amount of oxygen and nutrients that are essential in repairing damaged tissue and removing waste products when muscles are exhausted (Makeeva, 2016).

Another approach that can be used to treat non-specific low back pain is the exercise therapy approach. Proprioceptive Neuromuscular Facilitation (PNF) is an approach to therapeutic exercise that combines a movement-based functional diagonal pattern with neuromuscular facilitation techniques to generate motor responses and improve neuromuscular control and function (Sawant and Ghodey, 2017). Previous studies have shown that the application of PNF in low back pain patients can reduce pain and improve lumbar function and mobility that were evaluated using the short-form McGill pain questionnaire and a modified schober test (Hosseinifar, et al., 2016).

Another exercise therapy that can be given is through Sensory Motor Training (SMT) which is a form of training that emphasizes postural control in maintaining synergistic stabilization of structures that support posture, especially in the spine (McCaskey, 2016). The process of re-education of the proprioceptive system and sensory motor training able to increase the ability of muscle adjustment to maximize sensory input in various parts of the body and increase motor adjustment capabilities. SMT is expected to be able to improve anticipatory postural control rather than strengthening only superficial and deep muscle groups such as in core stability exercises (Kanabar, 2016).

The interventions based on the ICF problem will determine the success of therapy and improvement in a person's body movements and functions. The combination of intervention through the application of electrotherapy, exercise therapy, and manual therapy is expected to provide significant improvements in patients with non-specific low back pain. Critical appraisals conducted in several RCT studies prove that the application of ultrasound therapy, kinesio tape, proprioceptive neuromuscular facilitation, and sensory motor training is effective in treating non-specific low back pain. A study that comparing proprioceptive neuromuscular facilitation with sensory

motor training in ultrasound therapy intervention and kinesio tape insertion has never been done, therefore researchers are interested in raising this topic in addressing existing problems.

MATERIALS AND METHOD

Quantitative study design was a randomized controlled trial (RCT). This research was conducted in physiotherapy practice in Denpasar and Badung area. This study took place from August - October 2020. The target population in this study were individuals who clinically diagnosed with non-specific low back pain. Study participants were selected based on inclusion and exclusion criteria. The inclusion criteria included: (1) patient age between 18 - 50 years, (2) Numeric Rating Scale (NRS) examination scores from 3 - 8 (moderate), (3) experiencing acute - subacute cases (4 - 12 weeks). While the exclusion criteria included: spinal pathologies such as fractures, inflammatory pathologies such as ankylosing spondylitis, tumors, compression of the nerve roots (spondylolisthesis and disc herniation with emphasis on nerve roots, spinal stenosis), cancer, autoimmune disease, pregnancy, and contraindications while using kinesio tape.

The G*Power application is used to determine the sample size in this research. The effect size was determined through previous research (Areeudomwong and Buttagat, 2018). The α-error probability was set at 0.05 and the power (1- β error probability) was set at 0.80. Based on the calculation results, the number of samples is 7 respondents. To avoid drop out, the sample is added by 30% to become 9,1 or 10 study participants. Then there are 10 study participants for each group. The total number of study participants in both groups is 20 respondents.

In control group (n = 10) were given UST, PNF, and KT interventions while treatment group was given UST, SMT, and KT interventions (n = 10). In this study, blinding was carried out on study participants, research assistants who took measurements, and physiotherapists who provided intervention techniques. The sampling technique was carried out by simple random sampling, which was to first count the number of subjects/participants in the accessible population who would be selected as research participants, then the researcher randomized them with blocked randomization technique.

The independent variables in this RCT study were a combination of UST, PNF, and KT insertion and a combination of UST, SMT, and KT insertion. While the dependent variable namely: pain is measured by a numeric rating scale, range of motion is measured by a goniometer, and low back disability is measured by the Indonesian version of Modified Oswestry Disability Index (MODI) (Nugraha, et al., 2019).

UST application methods include: gel is applied to the skin and to the transducer surface. Apply 3-4cm^2 of transducer movement per treatment area. The UST dosage applied includes: frequency (1MHz), intensity (0.4W/cm^2), pulsed ratio (1:3), treatment area (3 times the transducer), duration (12 minutes), and increased dose due to energy loss due to the target depth is about 0.70 W/cm^2 (Watson, 2017).

PNF application is carried out through 3 methods. The first method is to facilitate movement of the anterior pelvic elevation, posterior pelvic depression, anterior pelvic depression, and posterior pelvic elevation. The second method is through asimetrical exercise for trunk extension (posterior scapula elevation and pelvic posterior depression) and asimetrical exercise for trunk flexion (anterior scapular depression and pelvic anterior elevation). The third method is to facilitate lower extremity through (a) flexion-abduction-internal rotation with knee flexion, (b) flexion-abduction-internal

rotation with knee extension, (c) extension-adduction-external rotation with knee extension, (d) extension – adduction – external rotation with knee flexion, (e) flexion – adduction – external rotation with knee flexion, (f) flexion – adduction – external rotation with knee extension, (g) extension – abduction – internal rotation with knee extension, (h) extension – abduction – internal rotation with knee flexion. Each movement pattern is carried out 8-12 times repetitions (Adler, et al., 2013).

SMT is applied through abdominal bracing, bridging position, single leg raising in bridging position, single leg raising in quadruped position, and contralateral arm and leg raising in quadruped position. Each movement is performed 15 repetitions in 3 sets (Kanabar, 2016).

The method of KT insertion, includes: four I-shaped KT with a width of 5 cm and a thickness of 0.5 mm were used in this study. Two bands are applied when the lumbar flexion reaches its highest point as well as the position of the contralateral lumbar rotation. This band is applied vertically from the lower posterior iliac crest to the 12th rib in each paravertebral muscle with a KT stretch of 10-15%. The other two bands are attached diagonally to the sacrum with a stretch of 50-75% (Celenay and Kaya, 2019).

Experimental Procedure

The procedure for this RCT research includes: (1) applying for ethical permission to the ethics commission of the FK Unud/RSUP Sanglah, (2) the researcher selects the inclusion and exclusion criteria then conducts simple random sampling on the research participants and blinding on the research participants, the assistant team that takes measurements pre-test and post-test, as well as the physiotherapist who provided the intervention, (3) taking pre-test measurements (pain, range of motion, and low back disability) on the first day of intervention, (4) giving intervention for 3 times in 1 week for 3 weeks (9 sessions), (5) taking post-test measurements (pain, range of motion, and low back pain disability) a day after the intervention was given, and (6) conducting data analysis tests using statistical tests.

Data Analysis

Data analysis was carried out, including: (1) Descriptive test to determine the distribution of research participant data. (2) The normality test is performed on pain data, joint range of motion, and low back pain disabilities before and after treatment using the Saphiro-Wilk test to determine the data normality distribution. (3) Comparative analysis to examine differences in pain, range of motion, and low back disabilities, namely before and after treatment in each group using paired-sample t-test. (4) Different tests to test differences in pain, range of motion, and low back disabilities between the two groups using independent sample t-test.

Ethical Consideration

This study has obtained ethical eligibility approval with No. 1516/UN14.2.2.VII.14/LT/2020 from the Research Ethics Commission, Faculty of Medicine, Udayana University/ Sanglah Central General Hospital.

RESULTS

The research results are described in the following table:

Table 1. Characteristics of respondents

Characteristics	Control group (n=10)	Treatment group (n=10)	p value
Gender ƒ (%)			
Male	5 (50)	5 (50)	-
Female	5 (50)	5 (50)	
Age (years)			
Mean ± SD	39,60±4,14	39,30±4,11	0,873
NRS			
Mean ± SD	5,95±0,49	5,89±0,37	0,762
MODI			
Mean ± SD	28,00±4,34	30,50±4,00	0,198
ROM (Lumbar flexion)			
Mean ± SD	39,40±2,32	38,50±2,07	0,372
ROM (Lumbar extension)			
Mean ± SD	16,20±0,92	15,70±1,06	0,274

Based on the table above, it is found that the same characteristics between the control and treatment groups in terms of gender, age, level of pain, range of motion, and low back disability at the initial of the examination.

As a prerequisite for determining the statistical test to be used in testing the hypothesis, the normality test is used using the Shapiro-Wilk test. The results of the analysis are listed in Table 2.

Table 2. Normality test

Data group	Normality test[a]	
	Control group (p value)	Treatment group (p value)
NRS (pre-test)	0,200	0,666
NRS (post-test)	0,064	0,551
MODI (pre-test)	0,194	0,582
MODI (post-test)	0,050	0,156
Lumbar flexion ROM (pre-test)	0,204	0,553
Lumbar flexion ROM (post-test)	0,132	0,136
Lumbar extension ROM (pre-test)	0.149	0.111
Lumbar extension ROM (post-test)	0,025	0,025

Based on Table 2, it was found that the pre-test and post-test data were normally distributed. Parametric statistic test is used to test the hypothesis.

The mean reduction in pain scores, low back disability, and range of motion before and after the intervention in control and treatment group were tested by paired-sample t-test. The test results are listed in Table 3.

Table 3. Comparison Data in each Group

Data Group	Pre-Test	Post-test	95% CI		p value
	Mean±SD	Mean±SD	Lower	Upper	
(NRS)					
Control group	5,95±0,49	2,52±0,42	3,28	3,58	0,000
Treatment group	5,89±0,37	2,52±0,39	3,31	3,43	0,000
(MODI)					
Control group	28,00±4,34	10,70±3,65	16,47	18,13	0,000
Treatment group	30,50±4,00	13,40±4,95	16,06	18,14	0,000
(Lumbar flexion ROM)		53,10±2,76	-14,38	-13,02	0,000
Control group	39,40±2,32	52,70±2,26	-15,01	-13,39	0,000
Treatment group	38,50±2,07				
(Lumbar extension ROM)		26,20±0,78	-10,75	-9,24	0,000
Control group	16,20±0,92	25,80±0,78	-10,63	-9,57	0,000
Treatment group	15,70±1,06				

Based on Table 3, the results of improvement in pain score, low back disability, and range of motion in control and treatment groups with (p<0.05), which means that there is a significant difference in increasing the range of motion and reducing pain and low back disability before and after the intervention.

Table 4. Comparison Data between Groups

	Data Group	Mean±SD	p value
Pre-Test	Control group	5,95±0,49	0,762
(NRS)	Treatment group	5,89±0,37	
Post-Test	Control group	2,52±0,42	1,000
(NRS)	Treatment group	2,52±0,39	
Pre-Test	Control group	28,00±4,34	0,198
(MODI)	Treatment group	30,50±4,00	
Post-Test	Control group	10,70±3,65	0,182
(MODI)	Treatment group	13,40±4,95	
Pre-Test	Control group	39,40±2,32	0,372
(Lumbar flexion ROM)	Treatment group	38,50±2,07	
Post-Test	Control group	53,10±2,76	0,728
(Lumbar flexion ROM)	Treatment group	52,70±2,26	
Pre-Test	Control group	16,20±0,92	0,274
(Lumbar extension ROM)	Treatment group	15,70±1,06	
Post-Test	Control group	26,20±0,78	0,272
(Lumbar extension ROM)	Treatment group	25,80±0,78	

Comparison of improvements between groups, tested by independent sample t-test. The test results are listed in Table 4 above. Based on Table 4, it shows the results of the mean difference in pain score, low back disability, and range of motion between

groups, with (p>0.05), which means that there is no significant difference between the two groups.

DISCUSSION

The results showed that the combinations of UST + PNF + KT has the same good results as the combination of UST + SMT + KT (p>0.05) in reducing pain, improving joint range of motion, and disability in non-specific low back pain. In conjunction with exercise therapy to reduce pain, promote healing, and increase tissue extensibility, physiotherapists usually use therapeutic ultrasound. The latest systematic review with a total sample of 699 respondents showed that UST was able to reduce pain in patients with non-specific low back pain (Haile & Tekle, 2021). Previous systematic reviews have shown that UST will be more effective when combined with other therapies and is not given as a single therapy option (Noori *et al.*, 2020). UST have therapeutic effect such as: thermal and non-thermal. Ultrasonic energy increases molecular motion which increases tissue temperature, which in turn affects tissues in different ways; such as changing nerve conduction velocity and increasing pain threshold, increasing local blood flow and collagen repair. Morriset demonstrated that UST had the ability to heat the periarticular lumbar tissue to a sufficient degree to produce therapeutic effects with increased temperature that affects in reduced pain, tissue healing, altered collagen extensibility, and decreased joint stiffness (Ebadi, et al., 2013).

In this study UST combined with kinesio taping as the standard protocol was administered to two groups. A comprehensive review from (Trobec & Peršolja, 2017) explains that kinesio tape is effective in treating non-specific low back pain. Kinesio taping is an elastic band designed to support muscles, tendons and ligaments and reduce pain. Kinesio tape is an elastic, adhesive, non-latex tape made from 100% cotton. The tape is covered with a layer of hypoallergenic acrylic adhesive that is activated by body temperature. The flexibility of the KT allows it to be stretched up to 30-40% of its original length. KT is applied to the skin by removing the top layer of skin and creating more space between the skin and the underlying muscles. More space reduces pressure on the lymph ducts and creates more area for circulation. It helps reduce swelling and pain in the injured area. In addition, KT helps improve circulating blood flow and as a result, increases the amount of oxygen and nutrients that are essential in repairing damaged tissue and removing waste products when muscles are exhausted (Makeeva, 2016).

Recent study shows that PNF is effective in reducing pain (Anggiat *et al.*, 2018) and increasing lumbar range of motion (Anggiat *et al.*, 2020) in patients with non-specific low back pain. PNF is an approach to therapeutic exercise that combines movement-based functional diagonal patterns with neuromuscular facilitation techniques to evoke motor responses and improve neuromuscular control and function. PNF is designed to increase the response of neuromuscular mechanisms by stimulating proprioceptors. The movement patterns associated with PNF consisted of multi-jointed, multiplanar, diagonal and rotational movements of the extremities, trunk, and neck (Sawant and Ghodey, 2017). Previous studies have shown that administering PNF to low back pain patients can reduce pain and improve lumbar function and mobility after evaluation using short- form McGill pain questionnaire and modified schober test (Hosseinifar, et al., 2016).

Study from (McCaskey *et al.*, 2018) shows that postural SMT effective in improving functional status in patients with non-specific low back pain. SMT is a

training that emphasizes postural control in maintaining synergistic stabilization of structures that support posture, especially in the spine (McCaskey, 2016). The process of re-education of the proprioceptive system and sensory motor training is able to increase the ability to adjust muscles to maximize sensory input in various parts of the body and increase motor adjustment ability. SMT is expected to improve anticipatory postural control rather than strengthening only superficial and deep muscle groups such as in core stability exercises. Previous research comparing the effectiveness of core stability exercise with sensorimotor training has shown that SMT is more effective in reducing pain and disability in chronic low back pain, evaluated using a numeric rating scale and an Oswestry disability index (Kanabar, 2016).

CONCLUSION

The combinations of UST + PNF + KT has the same good results as the combination of UST + SMT + KT in reducing pain, improving joint range of motion, and disability in non-specific low back pain. This combination of interventions can be used as a therapeutic option in the clinical setting in providing services to patients with non-specific low back pain.

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